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AFSWP-397

Lab. Project 5046-3, Part 55
Final Report
NS 081-001

MATERIAL LABORATORY

NEW YORK NAVAL SHIPYARD
BROOKLYN 1, N. Y.

TECHNICAL REPORT

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CRITICAL THERMAL ENERGIES
of
CANOPY MATERIALS

Submitted by

THE WRIGHT AIR DEVELOPMENT CENTER
Department of the Air Force

L. Banet
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Lab. Project 5046-3, Part 55
Final Report
NS 081-001
Technical Objective AW-7
AFSWP-397

16 April 1954

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Lab. Project 5046-3, Part 55
Final Report

ABSTRACT

For the purpose of evaluating the resistance of materials to the thermal radiation of atomic explosions, the critical thermal energies and the apparent transmissions of six canopy materials were determined. The materials were evaluated by exposure to the Material Laboratory carbon-arc source of thermal radiation and examination of the consequent damage to the cloths. The amount of radiation transferred through the materials was determined by using black carbon paper, mounted with a 1/16-inch air gap behind the cloths. The methods of exposing the materials to determine initial energies and of measuring the apparent transmissions are indicated. It was found that initial effects, whenever observed, occurred between 7.2 and 27 cal/cm^2. Destruction of the cloths occurred at values ranging from 32 to 50 cal/cm^2, depending upon the material employed. Apparent transmittance values of less than 3 per cent were found on the two aluminized cotton materials and the butyl coated cotton sateen and the highest transmittance (9 per cent) on the white cotton sateen.

CONTENTS

Lab. Project 5046-3, Part 55
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Ref: (a) COMNAVSHIPYDNYK conf ltr S99/L5 Ser 960-92 of 14 Mar 1950
(b) BUSHIPS spdltr S99(0)(348) Ser 348-75 of 6 Apr 1950

Encl: (1) Critical Thermal Energies of Canopy Materials
(2) Apparent Transmission of Canopy Materials

AUTHORITY

1. This investigation is part of the program proposed by reference (a) and formally approved by reference (b). The investigation of the canopy materials was requested by the Wright Air Development Center. The general Thermal Radiation Program is under the supervision of the Armed Forces Special Weapons Project.

INTRODUCTION

2. As part of its general program on the effects of the thermal radiation of atomic explosions, the Naval Material Laboratory is evaluating the characteristics, under exposure to intense thermal radiation, of the various materials of particular interest to the several agencies of the Department of Defense. As data become available, these findings are published.

3. The six canopy fabrics were submitted to the Material Laboratory by C. A. Willis, Uniform Textile Section (WCRTT-2), Wright Air Development Center, on 12 January 1954.

EQUIPMENT AND METHODS

4. The critical thermal energies of the canopy materials were determined, employing the Naval Material Laboratory carbon-arc source of thermal radiation. The source consists of an 11-mm carbon arc, mounted at the focus of a reflector which collimates the emitted energy. A second mirror, which is mounted coaxially at a distance of twelve feet from the collimator, condenses the radiation to the mirror's focus. Gradations of thermal damage are obtained by varying the effective exposure time through accelerating a 1 x 8-inch specimen transversely through the focus. The carbon arc furnishes an irradiance of 85 $cal/cm^2 sec$ over a central area, 2-mm in width. For a better approximation of the laboratory exposure time to those associated with the radiation of a nominal atomic bomb, attenuating screens were employed. Exposure times between 0.3 and 0.6 seconds were employed for radiant exposures up to 53 cal/cm^2.

5. For the exposure, the fabrics were cut into 1x8-inch specimens and mounted 1/16-inch above a black, heat-sensitive carbon paper, fastened on glass melamine blocks which were provided with cut-cuts to furnish an air background behind the paper. Using attenuating screens, the exposures were increased up to a value of 50 cal/cm^2, and a glass silicone mask with several stops was employed to reduce flame propagation during exposure. Placing black carbon paper under the cloths and examining the resulting damage of the paper, an estimate of the radiation transmittance was obtained from the ratio of the exposure values required to produce certain effects on the paper to the total exposure values required to produce the effects directly.

RESULTS

6. The critical thermal energies of the canopy materials, submitted by the Wright Air Development Center, were defined as those which produce certain characteristic reproducible effects on the materials, such as charring or destruction. The measured critical energies are given in Enclosure (1).

7. It may be noted that the laboratory exposures have been made under highly controlled conditions and, as a rule, give results which can be reproduced very well. However, for several reasons, the data of Enclosure (1) should be used with caution. The effects to be observed on material surfaces remain unchanged over a considerable range of exposures. Since the surface effects are not sufficiently gradated for refined evaluations, only the initial stages have been recorded. The effects are influenced by such factors as mounting, geometry of material and of exposure, weathering and moisture content at the time of exposure. Differences in density, absorptivity, chemical composition, weave, and surface structure are ... responsible for the varying effects which may be observed from area to area on the same material. Liquids and gases form during exposure to thermal radiation, even in a period of less than one second, thereby affecting the amount of thermal radiation, incident on and absorbed by the surface. A review of the critical energy values shows the following:

(a) Except for flaming or total destruction, the first effects observed on the cloths occurred at radiant exposures of from 7.2 to 27 cal/cm^2.

(b) Of the six materials, the aluminized cotton showed the earliest effects, at 7.2 cal/cm^2.

(c) The most resistant of the materials were the white cotton sateen (9 oz/yd^2) and the silicone rubber coated glass fabric, which were not affected under radiant exposures up to 41 cal/cm^2.

(d) All of the materials flamed during exposure. The new aluminized cotton flamed at the lowest exposure values of 21 cal/cm^2 and the silicone rubber coated glass fabric, cotton sateen and cotton duck at 41 cal/cm^2, the highest value for this damage.

(e) The least resistant to destruction is the butyl rubber coated cotton sateen which was consumed at 32 cal/cm^2.

8. The apparent transmittance values of the fabrics, determined by the effects on the carbon paper, are shown on Enclosure (2). The two aluminized cotton materials and the butyl coated cotton sateen have transmittance values of less than 1 per cent below exposures of 9 cal/cm^2. For exposures up to 25 cal/cm^2, these threee materials have apparent transmittance values of less than 3.1 per cent. The remaining three materials transmit considerably more; the cotton sateen indicated the highest transmission value, approximately 9 per cent.

CONCLUSIONS

9. The results of this investigation are summarized as follows:

(a) Initial effects of the canopy materials occur after exposures ranging from 7.2 to 27 cal/cm^2.

(b) The materials flame during exposure at values ranging from 21 to 41 cal/cm^2.

(c) Butyle rubber coated sateen, cotton sateen, cotton duck and silicone rubber coated glass fabrics are progressively more resistant to destruction.

(d) The apparent transmittances of the aluminized cotton materials and the butyl coated cotton sateen are the lowest, that of the cotton sateen is the largest (approximately 9 per cent).

Approved:

B H Audrey

~~A.~~ B. JONES, ~~Jr., CA~~PTAIN, USN
By The Director

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Critical Thermal Energies
of
Canopy Materials

Submitted by the Wright Air Development Center

Department of the Air Force

MATERIAL	DESCRIPTION OF EFFECT	CRITICAL ENERGY (cal/cm^2)
Cotton, Aluminized Type I, new	Aluminum dulls	8.2
	Surface chars	18
	Flames during exposure	21
	Cotton chars through	31
	Destroyed by afterflame and afterglow	42
Cotton, Aluminized Type I, previously used in aircraft	Aluminum dulls	7.2
	Surface chars	9.5
	Cotton chars through	19
	Flames during exposure	24
	Destroyed by afterflame and afterglow	34
Cotton, Sateen, white, 9 oz/sq.yd., Mil-C-557	Destroyed by afterflame and afterglow	41-50
Butyl Rubber Coated Cotton Sateen	Surface chars	22
	Destroyed by afterflame	32
Bleached Cotton Duck 14.7 oz/sq.yd.	Chars sporadically	27
	Destroyed by afterflame and afterglow	41-50
Silicone Rubber Coated Glass Fabric	Flames during exposure and forms powdered ash	41

Apparent Transmission of Canopy Materials

Submitted by the Wright Air Development Center

Department of the Air Force

MATERIAL	EXPOSURE ON CLOTH (cal/cm^2)	APPARENT TRANSMISSION Indicated Effect (cal/cm^2)	APPARENT TRANSMISSION Per cent
Cotton, Aluminized Mil-C-7646, Type (New)	8.8 25	0.059 <0.78	0.67 <3.1
Cotton, Aluminized, Mil-C-7646, previously used in aircraft	8.6 25.0	0.059 <0.78	0.69 <3.1
Cotton Sateen, white 9 oz/sq.yd., Mil-C-557	0.61 9.3	0.059 0.78	9.7 8.4
Butyl Rubber Coated Cotton Sateen	11 25	0.059 <0.78	0.53 <3.1
Bleached Cotton Duck 14.7 oz/sq.yd	16	0.78	4.9
Silicone Rubber Coated Glass Fabric	0.91 12	0.059 0.78	6.9 6.5

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